Code No: RR320306 **Set No. 1**

III B.Tech II Semester Regular Examinations, Apr/May 2006
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Define and explain Physical significance of Thermal conductivity, convection heat transfer Coefficient, thermal diffusivity, thermal resistance, thermal conductance and thermal contact resistance.
   (b) Discuss the mechanism of thermal conduction in gases and Solids.
   (c) Discuss the mechanism of heat convection.
   (d) What is the order of magnitude of thermal conductivity for metals, solid insulating materials, liquid and gases? [16]

2. A composite slab consists of 250 mm fire clay brick (k=1.09 W/mK) inside, 100 mm fired earth brick(0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at 1200^0C and outside surface is at 100^0C, find
   (a) heat flux,
   (b) the temperature of the junctions and
   (c) the temperature at 200 mm from the outer surface of the wall. [16]

3. A wall of thickness 100 mm is insulated on one side and other side is exposed to 0^0C. Determine the wall temperature insulated surface if the internal heat generation in the wall is at the rate of 10^6 W/m^3. Take k = 40 W/mK. [16]

4. (a) Explain the advantage and limitations of dimensional analysis.
   (b) The coefficient of free convection at the surface of horizontal pipe may be computed from the relation:
   $N_u = \frac{hd}{k} = 0.053\,(P_r)^{0.5} * (P_r + 0.955)^{-0.25} * (G_r)^{0.25}$
   where, all the properties are evaluated at the surface temperature and coefficient of cubical expansions, = 1/T , T being the Absolute air temperature, use this relation to calculate the heat loss by natural convection per meter length from horizontal pipe of 15 cm diameter.The surface temperature of the pipe is 275^0C and the surroundings are at 17^0C.
   At the surface temperature of 275^0C, the thermo-physical property of air is:

   $P_r = 0.675$
   $\rho = 0.6445$ kg/m^3
   k = 3.81 * 10-2 kcal/m-hr-deg.
   $\mu = 2.91$ x 10^{-6} kgf -s/m^2 [6+10]

5. (a) Write down differential equation for continuity of fluid flow.
   (b) In an ice plant liquid ammonia flows through a rectangular pipe of section 50 mm x 25 mm, at a velocity of 1 m/min and inlet temperature of -30^0C and leaves at 0^0C. Estimate heat transfer co-efficient and heat transfer rate.[6+10]

6. (a) Estimate peak heat flux and minimum heat flux for water boiling at atm pressure.
   (b) In pool boiling on a horizontal surface with water at atmospheric pressure the heat flow is 50 kW/m^2. Make calculations for surface temperature required. How does this value compare if the boiling occurs on a vertical flat plate? Use the following correlations.

   Nu = $0.16\ (GrPr)^{0.33}$ for boiling on horizontal plate

   = $0.16\ (GrPr)^{0.25}$ for boiling on vertical plate. [6+10]

7. (a) Distinguish between a black body and grey body.
   (b) Prove that intensity of radiation is given by $I_b = E_b/\Pi$
   (c) State and explain Kirchoff's identity? What are the condition's under which it is applicable. [4+6+6]

8. A heat exchanger (17.2 m^2) is used to cool oil at 200^0C by water available at 20^0C . The mass flow and sp.heat of oil are 10000 kg/hr and 1. 9 kJ/kg-K and corresponding values for water are 300W/m^2-K. Find the outlet temperature of oil and water for parallel flow and counter flow arrangements using (a)LMTD method and (b) NTU method. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR320306 **Set No. 2**

III B.Tech II Semester Regular Examinations, Apr/May 2006
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) One side of a plane wall is maintained at 100^0 C, while the other side is exposed to a convection environment having T=10^0 C and h= 11 W /m^2 K The wall has k = 1.6 W/m K and is 40 cm thick. Calculate the heat transfer rate through the wall.

   (b) A 6 mm steel plate having a thermal conductivity of 43 W / m K is exposed to a radiant heat flux of 4.9 kW /m^2 in a vacuum space where the convection heat transfer is negligible. Assuming that the surface temperature of the steel exposed to the radiant energy is maintained at 40^0 C, What will be the other surface temperature if all the radiant energy striking the plate is transferred through the plate by conduction? [16]

2. (a) Develop an expression for the steady state temperature distribution in a long hollow cylinder, $r_i < r < r_0$ in which heat generated at a rate of q(r) = q_0(1+Ar) W/m^3, where A and q_0 are constants while the boundary surfaces are kept at zero temperature.

   (b) An electric resistance wire of radius 0.001 m with thermal conductivity of 25 W/m K is heated by a passage of electric current which generates heat within the wire at a constant rate of 2x10^7 W/m^3. Determine the center line temperature rise above the surface temperature of the wire if the surface is maintained at constant temperature. [8+8]

3. A wall of thickness 100 mm is insulated on one side and other side is exposed to 0^0C. Determine the wall temperature insulated surface if the internal heat generation in the wall is at the rate of 10^6 W/m^3. Take k = 40 W/mK. [16]

4. (a) The velocity and temperature distributions in a pipe line are known to be of the form $u(r) = C_1r + C_2r^2; T(r) = C_3 + C_4r + C_5r^2$ where C_1 through C_5 are constants. Obtain an expression for the bulk temperature.

   (b) Give momentum equation for fluid flow. [8+8]

5. (a) Calculate the average co-efficient of heat transfer for natural convection for a vertical plate 30.48 cm high at 51.67^0C. The surrounding air is at 23.9^0C. Also calculate the boundary layer thickness at the trailing edge of plate.

   (b) What is the criterion for transition from laminar to turbulent flow in free convective heat transfer. [12+4]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?

(b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is 120^0C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

7. (a) Define irradiation and radiosity.

   (b) What does radiation shape factor mean?

   (c) Two parallel black plates 0.5 by 1.0m are separated by 0.5m distance. One plate is at 1100^0C and the other at 600^0C. What is the net radiant heat exchange between the two plates?

   (d) Calculate the shape factor for a hemispherical surface closed by a plane surface. [4+2+6+4]

8. A multipass heat exchanger (two passes on shell side and four passes on the tube side) is designed for the cooling the oil . The oil is passed through the tubes and cooled from 134oC to 53^0C. The cooling water passing through the shell enter at 14^0C and leaves at 32^0C . Find the heat transfer rate for the following data. hI (oil) = 268 W/m^2-K ; h_0(water) = 962 W/m^2-K ; h(scale on water side) = 2832 W/m^2-K number of tubes per pass = 118.
   Length and outer diameter of each tube are 2m and 2.5cm thickness of tube = 1.6mm ; LMTD correction factor = 0.97 . Neglect the tube wall resistance. [16]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR320306 **Set No. 3**

III B.Tech II Semester Regular Examinations, Apr/May 2006
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) The surface of steel plate measuring 0.9m long x 0.6m wide x 0.025m thick is maintained at a uniform temperature of 300^0C, and the plate loses 250 watt by radiation. If air at 15^0C temperature and 20 w/m^2-deg convective heat transfer coefficient blows over the plate, calculate the temperature on inside surface of the plate. Take thermal conductivity of plate as 45w/m-deg.
   (b) Derive expressions for temperature distribution during steady sate heat conduction in a solid sphere with internal heat generation. [8+8]

2. A composite slab consists of 250 mm fire clay brick (k=1.09 W/mK) inside, 100 mm fired earth brick(0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at 1200^0C and outside surface is at 100^0C, find
   (a) heat flux,
   (b) the temperature of the junctions and
   (c) the temperature at 200 mm from the outer surface of the wall. [16]

3. (a) What is the critical thickness of insulation and explain its physical significance?
   (b) Derive its equation for a hollow cylinder and a hollow sphere? [6+10]

4. (a) The velocity and temperature distributions in a pipe line are known to be of the form $u(r) = C_1r + C_2r^2; T(r) = C_3 + C_4r + C_5r^2$ where C_1 through C_5 are constants. Obtain an expression for the bulk temperature.
   (b) Give momentum equation for fluid flow. [8+8]

5. What do you understand by the hydrodynamics and thermal boundary layers. Illustrate with reference to flow over a flat heated plate. [16]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?
   (b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is 120^0C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

7. (a) Distinguish between a black body and grey body.
   (b) Prove that intensity of radiation is given by $I_b = E_b/\Pi$

(c) State and explain Kirchoff's identity? What are the condition's under which it is applicable. [4+6+6]

8. (a) What is meant by "fouling" in heat exchangers mean? List the factors responsible for fouling.

(b) Water flows through a copper pipe (k=380 w/m-K) of 18mm diameter.it is surrounded by another steel pipe of 21mm and oil flow through the annular passage between copper and steel pipe .On the water side, the film coefficient is 4500 w/m^2-K and the fouling factor of .00032 m^2-K/W. The corresponding values for the soil side are 1250 W/m^2-K and .00082 m^2-K/W.find the overall heat transfer coefficient between water and oil. [6+10]

⋆ ⋆ ⋆ ⋆ ⋆

Code No: RR320306 **Set No. 4**

III B.Tech II Semester Regular Examinations, Apr/May 2006
HEAT TRANSFER
(Mechanical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) The surface of steel plate measuring 0.9m long x 0.6m wide x 0.025m thick is maintained at a uniform temperature of 300^0C, and the plate loses 250 watt by radiation. If air at 15^0C temperature and 20 w/m^2-deg convective heat transfer coefficient blows over the plate, calculate the temperature on inside surface of the plate. Take thermal conductivity of plate as 45w/m-deg.
   (b) Derive expressions for temperature distribution during steady sate heat conduction in a solid sphere with internal heat generation. [8+8]

2. A composite slab consists of 250 mm fire clay brick (k=1.09 W/mK) inside, 100 mm fired earth brick(0.26 W/mK) and outer layer of common brick (0.6 W/mK) of thickness 50 mm. If inside surface is at 1200^0C and outside surface is at 100^0C, find
   (a) heat flux,
   (b) the temperature of the junctions and
   (c) the temperature at 200 mm from the outer surface of the wall. [16]

3. (a) Derive the expression for temperature distribution with solid slab with heat generation of 1. Both surface temperatures of the slab are T_w K and at the center is T_0 K.
   (b) A long cylinder rod of radius 50 cm with thermal conductivity of 10 W/mK contains radioactive material, which generates heat uniformly within the cylinder at rate of 3X10^5 W/m^3. The rod is cooled by convection from its cylindrical surface into the ambient air at $T_\alpha = 50^0$C with a heat transfer coefficient of 60 W/m^2K. Determine the temperature at the end center and at the outer surface of the cylindrical rod? [7+9]

4. (a) Give a general equation for the rate of heat transfer by convection.
   (b) List the various factors on which the value of this coefficient depends. [10+6]

5. (a) Using a linear velocity profile u/$u\alpha$=y/δ, for flow over a flat plate, obtain an expression for the boundary layer thickness as a functions of x.
   (b) Air at 27^0C flows over a flat plate at a velocity of 2 m/s. The plate is heated over its entire length to a temperature of 60^0C. Calculate the heat transfer for the first 20 cm of the plate. [8+8]

6. (a) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why?

(b) Dry saturated steam at a pressure of 2.5 bar condenses on the surface of a vertical tube of height 1.5m. The tube surface temperature is 120^0C. Estimate the thickness of the condensate film and the local heat transfer coefficient at a distance of 0.3m from the upper end of the tube. [6+10]

7. (a) Distinguish between a black body and grey body.
   (b) Prove that intensity of radiation is given by $I_b = E_b/\Pi$
   (c) State and explain Kirchoff's identity? What are the condition's under which it is applicable. [4+6+6]

8. A counter flow heat exchanger operates under the following conditions
   Fluid : A inlet and outlet temperature 80^0C and 40^0C
   Fluid : B inlet and outlet temperature 20^0C and 40^0C
   If the overall heat transfer is increased by 10% and inlet temperature of fluid B is changed by 30^0C, what will be a new outlet temperature of a fluid A and B . Assume heat transfer coefficients and Capacity ratios are unaltered by temperature changes. [16]

⋆ ⋆ ⋆ ⋆ ⋆